We claim:

1. A method for cancellation of cross-talk among multiple channels occurring in a traditional Optical amplifier (OA), the method comprising the steps of:

detecting tones at an input and an output of a Smart Optical Amplifier (Smart OA), the Smart OA comprising the traditional OA and a Cross-talk Cancellaton Unit (XTCU);

comparing the detected tones at the input and output of the Smart OA;

generating destructive tones with such amplitudes and phases so as to cancel cross-talk; and

eradicating cross-talk at the output of the Smart OA by applying the destructive tones in the XTCU.

2. A method as claimed in claim 1, wherein the step of detecting tones at the input and the output of the Smart OA comprises the steps of:

tapping input and output optical signals at the input and the output of the Smart OA;

converting tapped optical signals into electrical signals; and

detecting a pilot tone at the input and output of the Smart OA.

3. A method as claimed in claim 1, wherein the steps of comparing the detected tones and generating the destructive tones comprise the steps of:

processing the electrical signals corresponding to the input and output of the Smart OA in a Processing and Control Unit (PCU) and a gain information signal from the Smart OA for the PCU; and

generating cross-talk cancellation tones by the PCU.

4. A method as claimed in claim 3, wherein the step of processing the electrical signals in the PCU comprises the step of processing the electrical signals in an analog PCU including an amplitude and phase adjustment unit and an analog comparator unit.

5. A method as claimed in claim 4, wherein the step of processing the electrical signals in the analog PCU further comprises the steps of:

performing adjustments of the output signal of the Smart OA using a gain information signal provided by the traditional OA when gain of the traditional OA is changed; and

comparing frequency domain spectra of the input and the processed output signals of the Smart OA by the analog comparator unit and generating the cross-talk cancellation tones.

6. A method as claimed in claim 5, wherein the step of comparing the frequency domain spectra and generating the cross-talk cancellation tones further comprises the steps of:

identifying the cross-talk tones and determining if the cross-talk tones are greater than a predetermined noise floor threshold; and

generating a sum of all the cancellation tones with such amplitudes and phases as an output of the PCU so as to eradicate cross-talk when the cross-talk tones are greater than said noise floor threshold.

7. A method as claimed in claim 4, wherein the step of detecting tones comprises detecting tones at the input and the output of the Smart OA that includes an Erbium Doped Fiber Amplifier (EDFA) and the XTCU.

8. A method as claimed in claim 7, wherein the step of eradicating cross-talk at the output of the Smart OA comprises modulating a pump laser in the EDFA by using the output of the analog PCU.

9. A method as claimed in claim 8, wherein the step of modulating the pump laser in the EDFA further comprises the steps of:

inserting a pump signal into an Erbium Doped Fiber Coil (EDFC) within the EDFA through a pump add filter of the EDFA; and

removing a remaining pump signal at the output of the EDFC by a pump drop filter of the EDFA.

10. A method as claimed in claim 4, wherein the step of processing the electrical signals comprises the step of detecting tones at the input and the output of the Smart OA that includes a Semiconductor Optical Amplifier (SOA) and the XTCU.

11. A method as claimed in claim 10, wherein the step of eradicating cross-talk at the output of the Smart OA comprises a step of modulating an electrical pump in the SOA by using the output of the analog PCU.

12. A method as claimed in claim 4, wherein the step of processing the electrical signals in the analog PCU comprises the step of detecting tones at the input and the output of the Smart OA that includes the EDFA and an electrically controlled Variable Optical Attenuator (eVOA)-based XTCU.

13. A method as claimed in claim 12, wherein the step of eradicating cross-talk at the output of the Smart OA comprises the step of controlling attenuation of the eVOA by using the output of the analog PCU.

14. A method as claimed in claim 4, wherein the step of processing the electrical signals comprises the step of detecting tones at the input and the output of the Smart OA that includes the SOA and the eVOA-based XTCU.

15. A method as claimed in claim 14, wherein the step of eradicating cross-talk at the output of the Smart OA comprises the step of controlling attenuation of the eVOA using the output of the analog PCU.

16. A method as claimed in claim 3, wherein the step of processing the electrical signals in the PCU comprises the step of processing electrical signals in a digital PCU, comprising A/D converters, tone detectors, an amplitude and phase adjustment unit, and a digital comparator unit.

17. A method as claimed in claim 16, wherein the step of processing of the electrical signals in the digital PCU further comprises the steps of

converting said signals from analog to digital by the A/D converters;

converting the digital signals, which are in time domain into frequency domain spectra by the tone detectors;

performing adjustments of the converted Smart OA output signal, using a gain information signal provided by the traditional OA when the traditional OA gain is changed; and

comparing the frequency domain spectra of the input and the processed output signals of the Smart OA by the digital comparator unit and generating cross-talk cancellation tones.

18. A method as claimed in claim 17, wherein the step of comparing the frequency domain spectra and generating the cross-talk cancellation tones further comprises the steps of:

identifying the cross-talk tones and determining if the cross-talk tones are greater than a predetermined noise floor threshold; and

generating the cross-talk cancellation tones with such amplitudes and phases as an output of the digital PCU so as to eradicate the cross-talk, when the cross-talk tones are greater than said noise floor threshold.

19. A method as claimed in claim 16, wherein the step of processing the electrical signals comprises the step of detecting the tones at the input and the output of the Smart OA that includes the EDFA and the XTCU.

20. A method as claimed in claim 19, wherein the step of detecting the tones comprises converting the output of the digital PCU from digital to analog by using a D/A converter in the XTCU and modulating the pump laser in the EDFA by using the output from the D/A converter.

21. A method as claimed in claim 20, wherein the step of modulating the pump laser in the EDFA further comprises the steps of:

inserting a pump signal into the EDFC within the EDFA through a pump add filter of the EDFA; and

removing the remaining pump signal at the output of the EDFC by a pump drop filter of the EDFA.

22. A method as claimed in claim 16, wherein the step of processing the electrical signals comprises detecting the tones at the output of the Smart OA that includes the SOA and the XTCU.

23. A method as claimed in claim 22, wherein the step of detecting the tones comprises converting the output of the digital PCU from digital to analog by using the D/A converter and modulating an electrical pump in the SOA by using the output of the D/A converter.

24. A method as claimed in claim 16, wherein the step of processing the electrical signals comprises the step of detecting tones at the input and the output of the Smart OA, that includes the EDFA and the eVOA-based XTCU.

25. A method as claimed in claim 24, wherein the step of detecting tones comprises the step of converting output of the digital PCU from digital to analog by using the D/A converter and controlling the attenuation of the eVOA by using the output of the D/A converter.

26. A method as claimed in claim 16, wherein the step of processing the electrical signals comprises detecting tones at the input and the output of the Smart OA including the SOA and the eVOA-based XTCU.

27. A method as claimed in claim 26, wherein the step of detecting tones comprises the step of converting the output of the digital PCU from digital to analog by using the D/A converter and controlling the attenuation of the eVOA by using the output of the D/A converter.

28. A system for cancellation of cross-talk among multiple channels occurring in a traditional Optical Amplifier (OA), the system comprising:

a Smart Optical Amplifier (Smart OA) having an input and an output and comprising the traditional OA and a Cross-Talk Cancellation Unit (XTCU);

means for detecting tones at the input and the output of the Smart OA;

means for comparing the detected tones at the input and the output of the Smart OA and generating destructive tones with such amplitudes and phases so as to cancel the cross-talk; and

means for eradicating the cross-talk at the output of the Smart OA by applying the destructive tones in the XTCU.

29. A system as claimed in claim 28, wherein the means for detecting tones at the input and the output of the Smart OA comprises:

optical taps for tapping optical signals at the input and the output of the Smart OA;

optical to electrical converters for converting the tapped optical signals into electrical signals; and

means for detecting a pilot tone at the input and the output of the Smart OA.

30. A system as claimed in claim 28, wherein the means for comparing the detected tones and generating destructive tones further comprises:

a Process Control Unit (PCU) comprising means for processing the electrical signals and a gain information signal from the Smart OA; and

means for generating cross-talk cancellation tones.

31. A system as claimed in claim 30, wherein the PCU is an analog PCU.

32. A system as claimed in claim 31, wherein the analog PCU further comprises:

an amplitude and phase adjustment unit for performing adjustments of an output signal from the Smart OA using a gain information signal provided by the traditional OA when the gain of the traditional OA is changed; and

an analog comparator unit for comparing frequency domain spectra of the input and the processed output signals of the Smart OA and generating the cross-talk cancellation tones.

33. A system as claimed in claim 32, wherein the analog comparator unit comprises:

means for identifying the cross-talk tones and determining of the cross-talk tones are greater than a predetermined noise floor threshold; and

a tone generator for generating a sum of all the cancellation tones with such amplitude and phases as the output of the PCU so as to eradicate cross-talk, when the cross-talk tones are greater than said noise floor threshold.

34. A system as claimed in claim 31, wherein the Smart OA includes an EDFA and the XTCU.

35. A system as claimed in claim 34, wherein the EDFA includes a pump laser which is modulated by using the output of the analog PCU.

36. A system as claimed in claim 35, wherein the means for modulating further comprises:

a pump add filter for inserting a pump signal into an Erbium Doped Fiber Coil (EDFC) within the EDFA; and

a pump drop filter for removing a remaining pump signal at an output of the EDFC.

37. A system as claimed in claim 31, wherein the Smart OA includes an SOA and the XTCU.

38. A system as claimed in claim 37, wherein the SOA includes an electrical pump which is modulated by using the output of the analog PCU.

39. A system as claimed in claim 31, wherein the Smart OA includes the EDFA and an electrically controlled Variable Optical Attenuator (eVOA)-based XTCU.

40. A system as claimed in claim 31, wherein the Smart OA comprises the SOA and the eVOA-based XTCU.

41. A system as claimed in claim 30, wherein the PCU is a digital PCU.

42. A system as claimed in claim 41, wherein the digital PCU further comprises:

A/D converters for converting said signals from analog to digital;

tone detectors for converting the digital signals which are in time domain into frequency domain spectra;

an amplitude and phase adjustment unit for performing adjustments of an output signal from the Smart OA, using the gain information signal provided by the traditional OA when the traditional OA gain is changed; and

a digital comparator unit for comparing the frequency domain spectra of the input and the processed output signals of the Smart OA and generating the cross-talk cancellation tones.

43. A system as claimed in claim 42, wherein the digital comparator unit comprises:

means for identifying the cross-talk tones and determining if the cross-talk tones are greater than a predetermined noise floor threshold; and

means for generating the cancellation tones as the output of the digital PCU with such amplitude and phases so as to eradicate cross-talk, when the cross-talk tones are greater than the said noise floor threshold.

44. A system as claimed in claim 42, wherein the Smart OA includes the EDFA and the XTCU.

45. A system as claimed in claim 44, wherein the EDFA includes a pump laser which is modulated by using the output of a D/A converter used for converting the output of the digital PCU from digital to analog signal.

46. A system as claimed in claim 45, wherein the means for modulating the pump laser in the EDFA further comprises:

A pump add filter for inserting a pump signal into the EDFC within the EDFA; and

A pump drop filter for removing the remaining signal at the output of the EDFC.

47. A system as claimed in claim 42, wherein the Smart OA comprises the SOA and the XTCU.

48. A system as claimed in claim 47, wherein the SOA includes an electrical pump which is modulated by using the output of the D/A converter used for converting the output of the digital PCU from digital to analog signal.

49. A system as claimed in claim 42, wherein the Smart OA comprises the EDFA and the eVOA-based XTCU.

50. A system as claimed in claim 44, wherein the Smart OA comprises the SOA and the eVOA-based XTCU.